Claims

1. A method of closed loop wireless communication of signals using an adaptive transmit antenna array (3), in which a plurality of copies of signals to be transmitted by said transmit antenna array (3) are produced with delays and weights (w_n^j) that are functions of the multi-path transmission channel characteristics ($\mathbf{H}$) from said transmit antenna array (3) to a receive antenna array (4) of a receiver (2) and are combined before transmission by said transmit antenna array (3),
characterised in that the delays and weights (w_n^j) of the transmit copies for each transmit antenna element (*n*) are functions of the respective multi-path transmission channel characteristics ($h_{n,m=1}^{l=1},\ldots,h_{n,m=M}^{l=L}$) from that transmit antenna element to the receive antenna array such that the multi-path signal components propagated to each receiver element are received with distinguishable delays according to the propagation path, and that said receiver (2) combines the received signal components from each receive antenna element with delays and weights (***u***) that are respective functions of the multi-path transmission channels.

2. A method as claimed in claim 1, wherein said receiver comprises a multi-finger RAKE receiver (6) that copies the received signals from said receive antenna array with delays and weights (***u***) that are respective functions of the multi-path transmission channels and combines the copied received signals.

3. A method as claimed in claim 1 or 2, wherein said delays and weights (w_n^j) of the multi-path transmit copies are respective functions of the multi-path transmission channel characteristics ($h_{n,m=1}^{l=1},\ldots,h_{n,m=M}^{l=L}$) from each transmit antenna such as to maximise at least approximately the output of said receiver (2).

4. A method as claimed in claim 3, wherein said delays and weights of said transmit copies are substantially equal to a matrix $\mathbf{w}$, where $\mathbf{w}_i=(w_{i,1},w_{i,2},\ldots,w_{i,M})^t$

represents the coefficients of the FIR filter applied on transmit antenna #*i* and *M* is the number of elementary time intervals in the FIR filter delay scheme, and wherein $\mathbf{w}$ is calculated to be substantially equal to the eigenvector corresponding to the largest eigenvalue of the matrix $\mathbf{H}^H\mathbf{H}$, where $\mathbf{H}$ is the matrix of the equivalent channel seen by the symbol data and $\mathbf{H}^H$ is the Hermitian transform of the matrix $\mathbf{H}$.

5. A method as claimed in claim 4, wherein said delays and weights applied by said receiver (2) are substantially equal to $\mathbf{u}=\frac{\mathbf{w}^H\mathbf{H}^H}{\sqrt{\mathbf{w}^H\mathbf{H}^H\mathbf{H}\mathbf{w}}}$.

6. A method as claimed in claim 1, wherein the number and delay position of said multi-path transmit copies are selected as a function of the number of multi-path trajectories between the transmit antennas (3) and the receive antennas (4).

7. A method as claimed in claim 6, wherein the delay positions of said multi-path transmit copies for a given transmit antenna element and the receive antenna array are selected to be substantially equal to $0, q_Q - q_{Q-1}, \ldots, q_Q - q_1$, where $q_1T_s, q_2T_s, \ldots, q_QT_s$, represent the delays of the Q non-null trajectories between that transmit antenna element and the receive antenna array.

8. A method as claimed in claim 6, wherein said weights of said transmit copies are substantially equal to a vector $\mathbf{w}$, where $\mathbf{w}_i = (w_{i,1}, w_{i,2}, \ldots, w_{i,M})^t$ represents the coefficients of the FIR filter applied on transmit antenna #*i* and M is the number of elementary time intervals in the FIR filter delay scheme, and $\mathbf{w}$ is calculated to be substantially equal to the eigenvector corresponding to the largest eigenvalue of the matrix $\mathbf{G}^H\mathbf{G}$, where $\mathbf{G}^H$ is the Hermitian transform of the matrix $\mathbf{G}$ and $\mathbf{G}$ is derived from $\mathbf{H}$, which is the matrix of the equivalent channel seen by the symbol data, by setting to null the weight columns in the matrix corresponding to unselected delay values.

9. A method as claimed in claim 7, wherein said delays and weights applied by said receiver are substantially equal to $\mathbf{u}=\frac{\mathbf{w}^{H}G^{H}}{\sqrt{\mathbf{w}^{H}G^{H}G\mathbf{w}}}$.

10. A method as claimed in claim 1 or 2, wherein the maximum delay between said multi-path transmit copies for any one transmit antenna is substantially equal to the maximum delay between the multi-path trajectories between that transmit antenna and the receive antennas.

11. A transmitter for closed loop wireless communication of signals comprising an adaptive transmit antenna array (3), finite impulse response filter means (5) for producing multi-path copies of the signals to be transmitted by said transmit antenna array with delays and weights (w_n^j) that are functions of the multi-path transmission channel characteristics ($\mathbf{H}$) from said transmit antenna array (3) to a receive antenna array (4) and for combining the copied signals before transmission by the transmit antenna array (3),
characterised in that the delays and weights (w_n^j) of the transmit copies for each transmit antenna element (*n*) are functions of the respective multi-path transmission channel characteristics ($h_{n,m=1}^{l=1},\ldots,h_{n,m=M}^{l=L}$) from that transmit antenna element to the receive antenna array (4) such that the multi-path signal components propagated to each receiver element are received with distinguishable delays according to the propagation path, and that the transmitted signals are suitable for reception by a receiver (2) that combines the received signal components from each receive antenna element with delays and weights (***u***) that are respective functions of the multi-path transmission channels

12. A transmitter as claimed in claim 11, comprising channel information means (16) for receiving channel information from said receiver.

13. A transmitter as claimed in claim 12, wherein said channel information means comprises a store for possible delay and weight combination functions of the copied signals and said channel information means (16) identifies delay and

weight combination functions from said store as a function of said channel information from said receiver.

14. A transmitter as claimed in claim 11 suitable for performing a method according to any of claims 1 to 10.

15. A receiver comprising a receive antenna array (4) having at least one receive antenna for reception by closed loop wireless communication of signals from a transmitter (1) comprising an adaptive transmit antenna array (3), characterised in that said receiver comprises combining means (18 to 21) for combining the received signal components from each receive antenna element with delays and weights (***u***) that are respective functions of the multi-path transmission channels ($\mathbf{H}$) according to functions suitable for receiving a plurality of multi-path signal components combined at the transmitter and propagated to that receiver element by said transmit antenna array with delays and weights (w_n^j) for each transmit antenna element (*n*) that are functions of the respective multi-path transmission channel characteristics ($h_{n,m=1}^{l=1},\ldots,h_{n,m=M}^{l=L}$) from that transmit antenna element such that said multi-path signal components are received with distinguishable delays according to the propagation path.

16. A method as claimed in claim 15, wherein said receiver comprises a multi-finger RAKE receiver (6) that copies the received signals from said receive antenna array with delays and weights (***u***) that are respective functions of the multi-path transmission channels and combines the copied received signals.

17. A receiver as claimed in claim 15 or 16, comprising channel information means (22, 25) for sending channel information to said transmitter (1).

18. A receiver as claimed in claim 17, wherein said channel information means (22, 25) comprises a store for possible delay and weight combination functions of the copied signals and said channel information means identifies functions from said store as a function of said channel information for said transmitter (1).

19. A receiver as claimed in claim 15 suitable for performing a method according to any of claims 1 to 9.